Antibiotic susceptibility in *Salmonella* swine isolates

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Abstract: Ninety-six percent of tested *Salmonella* swine isolates showed reduced antibiotic susceptibility. The lowest susceptibility was identified in the case of streptomycin, sulphonamides, nalidixic acid and tetracycline. The decrease in susceptibility for amoxicillin, ampicillin, enrofloxacin and chloramphenicol was observed in strains isolated during two four-year periods. Several strains developed multiresistance covering up to 9 antibiotics. Antibiotic susceptibility must be monitored to prevent therapeutic failures and spread of resistance genes in animals and humans.

Keywords: pigs, resistance, *Salmonella* serovars.

Introduction: The selective pressure of antibiotics used for control and prevention of the diseases or growth promotion in swine resulted in the decreased susceptibility of bacterial pathogens including *Salmonella*. The are two aspects of antibiotic resistance: therapeutic failure implications and the selection and spread of resistance genes that rises public health concerns. Resistant *Salmonella* strains have been recently isolated with increasing frequency (Helmuth, 2000, Hakanen et al., 1999, Winokur et al., 2000). Recently *Salmonella* Choleraesuis, Typhimurium and Agona have been the most frequently encountered in Poland (Hoszowski et al., 2000). The aims of the study were the evaluation of antibiotic susceptibility in *Salmonella* swine isolates, determination of the frequency of multiresistance and identification of the trends in *Salmonella* resistance.

Materials and Methods: Eighty-four *Salmonella* swine isolates obtained from 1994 to 2001 were included in the study on one strain per herd per year basis. They were isolated from internal organs, faeces, rectal swabs and pork. Sixteen *Salmonella* serovars were noted: Choleraesuis (54), Typhimurium (6), Agona (6), Enteritidis (4), Kapemba (2) and single isolates of Anatum, Parkroyal, Chester, Derby, Dublin, Hadar, Livingstone, Newlands, Oranienburg, Tennessee, Thompson and rough *Salmonella*. Antibiotic susceptibility testing was performed by agar diffusion method according to NCCLS guidelines (1997). The panel of 19 antimicrobials was applied (Table 1). The results were recorded and analysed with Whonet 5 software. Comparing the results obtained for *Salmonella* strains isolated

within two four-year periods, 1994-1997 and 1998-2001, the trends in antibiotic susceptibility were assessed with contingency test at 0.05 significance.

Results: *S.* Choleraesuis and *S.* Typhimurium were more frequently isolated from internal organs whereas the other *Salmonella* serovars were found mostly in faeces, rectal swabs and pork ($p \leq 0.01$). *Salmonella* antibiotic susceptibility and its trends were shown in Table 1.

Antimicrobial agents	Percentage of tested strains (n = 84)			Trends in antibiotic susceptibility				
				No. of isolates				Statistical significance p = 0.05
	R	I	S	1994-97 (n = 43)		1998-2001* (n = 41)		
				Non-S** (%)	S	Non-S** (%)	S	
gentamycin	0	0	100	0	43	0	41	-
kanamycin	0	0	100	0	43	0	41	-
neomycin	0	2	98	0	43	2 (5)	39	-
amikacin	0	0	100	0	43	0	41	-
streptomycin	72	13	15	34 (79)	9	37 (90)	4	n. s.
cefuroxime	2	2	96	2 (5)	41	2(5)	39	n. s.
amoxicillin	21	1	78	3 (7)	40	16(39)	25	$p \leq 0.001$
ampicillin	20	0	80	2 (5)	41	15 (36)	26	$p \leq 0.001$
nalidixic acid	10	27	63	13 (30)	30	18 (44)	23	n. s.
enrofloxacin	4	6	91	1 (2)	42	7 (17)	34	$p \leq 0.05$
ciprofloxacin	0	0	100	0	43	0	41	-
sulphonamides	43	0	57	20 (47)	23	16 (39)	25	n. s.
cotrimoxazole	8	1	91	3 (7)	40	5 (12)	36	n. s.
trimethoprim	8	0	92	3 (7)	40	4 (10)	37	n. s.
polymixin B	0	0	100	0	43	0	41	-
colistin	0	0	100	0	43	0	41	-
chloramphenicol	11	0	89	1 (2)	42	8 (20)	33	$p \leq 0.05$
tetracycline	17	23	60	14 (33)	29	19 (46)	22	n. s.
furazolidone	0	2/2	98	0	43	2 (5)	39	-

Table 1. Antimicrobial susceptibility in *Salmonella* swine isolates; * 1st quarter 2001 included; ** Non-susceptible includes resistant and intermediate strains

Of 84 strains tested 81 (96%) were either resistant or intermediate susceptible to at least one antibiotic. Multiresistance (comprising 4 and more antibiotics) was noted in 22 (26%) isolates. It was more frequent in 1998-2001 than in 1994-1997 *Salmonella* isolates ($p \leq 0.05$). Resistance to 6 – 9 antibiotics was found in *S.* Typhimurium (5), *S.* Choleraesuis (6) *S.* Kapemba (2), and *S.* Thompson (1).

Discussion: *S.* Choleraesuis and *S.* Typhimurium are the major cause of swine salmonellosis. Other serovars are mostly recognised as feed derived infection (Fedorka-Cray et al., 2000). All *Salmonella* strains showing reduced antibiotic susceptibility threat animal and human health. The levels of streptomycin and sulphonamides susceptibility remain stable although the most widely distributed. Cotrimoxazole, trimethoprim, nalidixic acid and tetracycline susceptibility remains

low and stable. Distinct increase of β-lactams resistance is noted. Cephalosporin-resistance do not follow that trend although extended-spectrum β-lactamase producing *Salmonella* are observed world-wide (Winokur et al., 2000). Decreasing enrofloxacin susceptibility demonstrates the major problem of quinolone resistance in *Salmonella* originated from animals (Hakanen et al., 1999), but fortunately it does not concern ciprofloxacin. Chloramphenicol, although no longer used in therapy of swine, shows decreasing susceptibility resulting presumably from the spread of multiresistant *Salmonella* strains (Helmuth, 2000). Peptides, furazolidone and most of aminoglycosides are still lethal for majority of salmonellas although the therapeutic use in swine is restricted. It is concluded that swine are important source of resistant *Salmonella* strains that can cause therapeutic failures and participate in the spread of multiresistance genes. Therefore resistance must be monitored to support the prudent use of antibiotics in animals.

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